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MARTIAN IMPACT BASINS: MORPHOLOGY DIFFERENCES AND TECTONIC PROVINCES. Marianne Stam*, Peter H. Schultz**, and George E. McGill* (*Dept. of Geology and Geography, Univ. of Massachusetts, Amherst, MA 01003; **Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058)

Detailed geomorphic and structural mapping of five martian basins and preliminary study of eleven other basins reveal four characteristic styles of modification that relate to the degree and age of past tectonic activity. Within regions that exhibit no evidence for tectonic activity ("inactive"), the modification style can be used to distinguish areas dominated by different exogenic processes. This study provides a framework for understanding these different styles of basin modification (1).

Basins in regions that have experienced extensive tectonic activity ("active") consist of two types that depend on whether the structures present are due to extension or to compression. Al Qahira, Aram Chaos, Chryse, Ladon, and Mangala are in extensional crustal regimes; they are characterized by chaotic terrain, well developed runoff and outflow channels, numerous floor-fractured craters (Table 1) and, with the exception of Mangala (which is largely obscured), low ring-spacing values. These geomorphic characteristics vary somewhat among the five basins, perhaps as a function of relative distance from Tharsis and Elysium. For example, Al Qahira is much closer to the older Elysium province than are Ladon and Aram Chaos, and the latter two have better preserved floor-fractured craters, chaotic terrain, and outflow channels. From counts of craters $\geqslant$5km in diameter, the chaotic terrain associated with Al Qahira is older than that associated with Ladon. These observations are consistent with modification of the basins at different times; earlier for basins closer to the older center of tectonic activity, Elysium. As a group, these five basins appear to have suffered the most endogenic modification of any on Mars. This is inferred to be the result of their settings within areas dominated by relatively recent extensional tectonics.

Sirenum basin is located in an "active" crustal region with NW-SE trending ridges believed due to compressional tectonics. Sirenum is degraded, with many heavily and lightly furrowed areas and furrowed craters. A large compressional ridge system collars the western portion of its innermost ring (2). Chaotic terrain and outflow and runoff channels are absent, and floor-fractured craters are rare, in contrast to the rejuvenated basins of the extensional regions near Tharsis and Elysium.

South of Lyot and Deuteronilus A and B ("active/inactive"), found on the martian crustal dichotomy boundary, are characterized by planated or inverted topography, fretted terrain, and "fretted channels" (3). They appear to have undergone complete planation, or were filled completely and later exhumed by mass wasting processes (1). Their complex history suggests extensive endogenic modification in the past but relatively "inactive" conditions now. Presently, the morphologies of these basins are dominated by exogenic (periglacial?) processes.

Basins in "inactive" crustal regions are characterized by a mantled appearance or by heavily furrowed and channelled basin rims (Table 1). Cassini and Cassini A are heavily mantled basins, with rings expressed by furrowed scarps rather than massifs or knobs. The furrowing is inferred to result from a mass-wasting process that "passively" rejuvenates the mantled rings (1). In other "inactive" crustal zones, basins are characterized by heavily furrowed and channelled rims, and by high ring-spacing

averages. Examples include: Schiaparelli, Huygens, Overlapped by Newcomb Crater, Overlapped by Schiaparelli, and West of Le Verrier (Table 1). Unlike the Cassini basins, these structures are mostly modified by erosional processes. Furrowing and channelling preserve the identy of their ring scarp forms while, at the same time, these processes are back-wasting the scarps. These basins are located in an "inactive" crustal region that is relatively old and is or was volatile rich.

In conclusion, martian impact basins express at least four major styles of modification. These styles of rejuvenation and degradation are important indicators of: 1) the intensity and age of past tectonic activity, 2) whether the tectonic activity was extensile or compressive, and 3) the types of exogenic processes that dominate in different stable crustal regions on Mars.

TABLE I Basin Characteristics

Crustal Setting		Basin Names	Location	Diameter (km)	# Craters > 40 km in 1×10^6 km	# Recognizable Rings	[°] Ring Spacing Index	Closest Distance (km) to Center of Tharsis Province	Closest Distance (km) to Center of Elysium Province	Distinguishing Group Characteristics
Active		Al Qahira	190° W, 20° S	[*]1056	42 ± 6	4	1.98	4604	2940	Chaotic terrain
		Aram Chaos	21.5°, 2.7° N	550		4	1.60	5376	8935	Outflow channels
		Chryse	45° W, 24° N	4300	[†]78 ± 16	6	1.39	4099	7714	Runoff channels
		Ladon	29° W, 18° S	[*]1700	48 ± 7	6	1.35	4963	10,225	Floor fractured craters
		Mangala	147° W, 0° N	570		2	1.91	2014	3984	
		Sirenum	166.7° W, 42.3° S	[*]1548	53 ± 7	4	1.42	3826	4664	
Inactive	Mantled	Cassini	328° W, 24° N	[*]930	60 ± 8	3	1.70	8127	5975	Heavily mantled
		Cassini 'A'	323.7° W, 13.7° N	[*]1214	84 ± 9	4	1.49	8612	6084	Furrowed scarps expressing rings
	Heavily channeled and furrowed	Huygens	304° W, 14° S	467		2	1.86	9617	5683	
		Overlapped by Newcomb Crater	3° W, 22.5° S	800		2	2.09	6387	9004	Heavily furrowed
		Overlapped by Schiaparelli	346.5° W, 5° S	560		2	3.98	7638	7592	
		Schiaparelli	343.2° W, 2.2° S	442		2	1.99	7645	7511	Heavily channelled rims
		West of Le Verrier	356° W, 37° S	430		1		6563	8597	
Active Inactive		Deuteronilus 'A'	342° W, 44° N	280		4	1.94	6929	5784	Inverted or planated topography
		Deuteronilus 'B'	338° W, 42.5° N	201		2	3.63	7121	5718	Fretted terrain
		South of Lyot	322° W, 41.6° N	570		6	1.55	7675	5180	'Debris aprons' Fretted channels

[†]From Schultz and Rogers (1984)
[*]Diameters determined from this work. All others from either Schultz, et al. (1982) or Croft (1979)
[°]This paramater equals the slope of the graph Log_{10} Ring diameter vs. Relative radial position of a ring in a given basin (after Pike 1981)

(1) Schultz, P.H., Schultz, R.A. and Rogers, J. (1982) Jour. Geophys. Research, p. 9803-9820. (2) Chicarro, A.F., Schultz, P.H., and Masson, P. (1983) Lunar and Planetary Science XIV, p. 88-89, Lunar and Planetary Institute, Houston. (3) Sharp, R.P. and Malin, M.C. (1975) Geol. Soc. Amer. Bull., 86, p. 593-609. (4) Croft, S.K. (1979) UCLA Ph.D. Dissertation. (5) Pike, R.J. (1981) Rpts. of Planetary Geology Program, NASA TM 84211, p. 123-125.